MOVEMENTS OF URBAN CANADA GEESE: IMPLICATIONS FOR NICARBAZIN TREATMENT PROGRAMS

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Abstract: Resident Canada goose (*Branta canadensis*) and human populations in North America are increasing rapidly. Consequently, human-goose conflicts also are increasing. A potential approach to manage Canada goose populations is the use of orally delivered reproductive inhibitors. Nicarbazin, when ingested daily, is a reproductive inhibitor that has the potential to reduce the hatchability of Canada goose eggs. To successfully employ reproductive inhibition, managers must understand the behavior of local Canada goose populations, primarily springtime movements, nesting, and habitat use to develop effective methods for delivering necessary doses. We monitored movement, habitat use, and nesting of 51 resident Canada geese, all adult females, at Bay Beach Wildlife Sanctuary (BBWS), Green Bay, Wisconsin, during 2001 and 2002. Our objective was to determine if geese were sufficiently sedentary during the nest initiation period to allow effective dosage with nicarbazin to assess its potential as a management tool. Our results indicated some geese never departed the area and were available for daily dosing while others departed and never returned. Goose movements and time spent away from BBWS were highly variable among geese; individuals traveled <1 km to 109 km from BBWS. However, movement patterns of individuals did not vary markedly between years. Similarly, nest sites were widely variable among geese but were consistent among years within individuals. Habitat use varied considerably among geese and included industrial complexes, urban lawns and parks, agricultural fields, and remote marshes. Overall, there was high variability among Canada geese in movement patterns, nesting, and habitat use. Such variability presents difficulty in delivering required doses of nicarbazin, or other reproductive inhibitors that must be ingested daily prior to and during egg laying.

Key words: behavior, *Branta canadensis*, Canada geese, fertility control, movement, nicarbazin, resident, wildlife damage management.

There are over 2.6 million resident Canada geese in the Unites States, and populations continue to grow (U.S. Fish and Wildlife Service 2002). Breeding populations exist in the 48 contiguous United States and every province of Canada. Concurrently, North America's human population also is increasing at an astounding rate of 4 million people/year (Dolbeer 1998). Consequently, conflicts between geese and people are increasing.

At high densities, geese can cause a wide variety of problems that include damage to agriculture (Flegler et al. 1987, Conover 1988), degradation of lawns (Conover 1991*a*), transmission of disease (Hussong et al. 1979; L. Clark, U.S. Department of Agriculture, unpublished report), reduction of water quality (Hussong et al. 1979, Manny et al. 1994), and risk to human safety (Fairaizl 1992, Dolbeer et al. 2000). Concern regarding these issues has resulted in considerable effort to develop efficient and cost-effective methods for managing overabundant goose populations. A draft environmental impact statement was released in February 2002, "to evaluate alternative strategies to reduce, manage, and control resident Canada goose populations in the continental United States and to reduce related damages (U.S. Fish and Wildlife Service 2002)."

Many strategies to manage overabundant geese have been evaluated (Smith et al. 1999), including relocation (Cooper 1987), habitat modification (Conover 1991b), chemical deterrents (Conover 1985, Cummings et al. 1991, Dolbeer et al. 1998), reproductive inhibition (VerCauteren et al. 2000, VerCauteren and Marks 2002), terrestrial hazing (Castelli and Sleggs 2000, York et al. 2000), aquatic hazing (VerCauteren et al., unpublished report), and clutch-size reduction via egg oiling or addling (Christens et al. 1995). For these techniques to be successful, managers need to understand the behavioral ecology and demographics (e.g., movement

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patterns, feeding habits, nesting success) of the targeted geese. Our objective was to examine movement patterns of an urban Canada goose population to ascertain if nicarbazin (NCZ), an orally delivered reproductive inhibitor that must be ingested daily during the egg-formation period, could be effectively administered to individuals in the population.

Nicarbazin was originally developed in the 1950s as a coccidiostat for broiler chickens and was subsequently found to reduce egg hatchability of laying hens (Chapman 1994). Nicarbazin has since been found to reduce egg hatchability in ducks (Johnston et al. 2002) and Canada geese (VerCauteren et al. 2000; VerCauteren, unpublished data) and is currently being evaluated by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, National Wildlife Research Center (NWRC) to determine its potential for controlling overabundant Canada goose populations. Research indicates that NCZ must be ingested daily for >16 days to impact the hatchability of all eggs in a clutch, from about 4 days prior to the first egg being laid until the last egg is laid (VerCauteren et al. 2000; VerCauteren and Marks 2002; VerCauteren, unpublished data). Nicarbazin clears from a bird's system in approximately 4 days (L. Miller, U.S. Department of Agriculture, unpublished data).

STUDY AREA

The Bay Beach Wildlife Sanctuary (BBWS) is located in Green Bay, Wisconsin, USA, at the southern tip of the Bay of Green Bay, Lake Michigan (44°32'N, 87°58'W, Fig. 1). The 285-ha BBWS has 22 ha of interconnected lagoons (J. P. Jacobs, J. A. Brue, and A. A. Badeau, City of Green Bay, Bay Beach Wildlife Sanctuary Master Plan, 1980). Geese primarily use 3 main lagoons (approximately 5, 2.5, and 2.5 ha, Fig. 1), which do not completely freeze over during the winter due to the use of aerators and the presence of geese. The BBWS is within 0.5 km of the Bay of Green Bay and is surrounded by urban and industrial development, including 3 wastewater treatment facilities. A purpose of BBWS is to provide outdoor and wildlife recreation and education opportunities for the public.

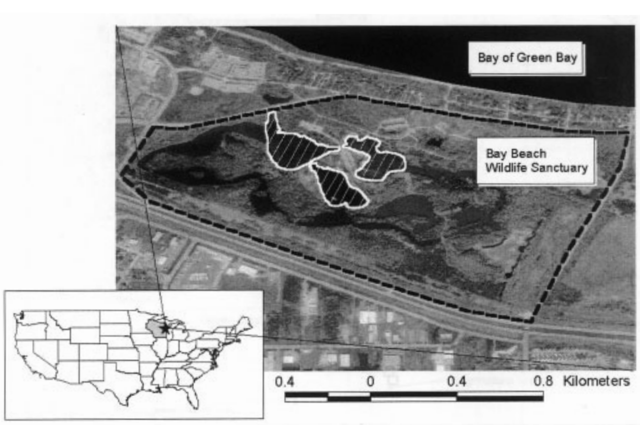

Fig. 1. Location of Bay Beach Wildlife Sanctuary, Green Bay, Wisconsin, USA, and the 3 lagoons primarily used by Canada geese.

The BBWS (managed by the city of Green Bay) was one of the first sites in the United States to establish a resident Canada goose population. Today, Green Bay is among many urban centers searching for efficient and cost-effective methods for managing its growing goose population. The resident goose population at BBWS now exceeds 300. In addition to the resident goose population, approximately 5,000 migrants have staged at BBWS from October through December in recent years.

With so many geese using the area, BBWS managers are faced with a variety of goose-related problems. Most importantly, BBWS has experienced a severe decline in lagoon water quality because goose feces accumulation has increased the rate of eutrophication (Foth and VanDyke 2001). Eutrophication has lead to the asphyxiation of nearly all aquatic species at BBWS. Only 2 of 9 original fish species, the black bullhead (*Ictalurus melas*) and the fathead minnow (*Pimephales promelas*) remain, because they are very tolerant of low oxygen levels. Few aquatic plants other than algae still exist. Additionally, aesthetic and recreational values of BBWS have decreased because lawns are littered with feces and feathers, shores are eroded and muddy, and the water is green year-round and smells foul at times.

METHODS

We equipped 51 adult female geese at BBWS with neck-mounted radio transmitters (Holohil Systems, Ontario, Canada). Twenty-six were captured in February and March of 2001, 20 more were captured in July 2001, and 5 additional were captured in March 2002. We fitted geese with U.S. Geological Service leg-bands and determined their sex by cloacal examination (Hochbaum 1942). Transmitters weighed 11.6 g and had a mean pulse rate of 0.65 pulses/second. Five previously neckbanded female geese were located frequently enough through visual observation to be included in the analysis, resulting in a sample size of 56 monitored geese.

Throughout the 2001 and 2002 breeding seasons (mid-Mar through mid-May), we conducted systematic daily telemetry searches to locate transmitter-equipped geese. Searches were conducted for approximately 8 hrs/day between 0500 and 1700 hrs, alternating commencement time between early and late morning. We also conducted 2 night searches per week, between 2000 and 2400 hrs, on arbitrary dates. Ground searches encompassed about 60 km^2 around BBWS. Hand-held and vehicle-mounted telemetry systems were used to locate geese for visual observation. From the ground, signal detection range was from 0.4 to 3 km, depending on the terrain and obstructions. To locate "lost" geese, we conducted 4 extensive aerial searches in 2001 and 2 in 2002. Aerial searches encompassed about 150 km^2 around BBWS. From the airplane, transmitter signals were detected from as far away as 13 km.

During ground searches, we determined locations of geese by obtaining the bearing and distance between the goose and the observer's position (UTMs marked with hand-held Global Positioning System [GPS]) (Garmin 12XL, Garmin, Olathe, Kansas, USA). We obtained bearings with a sight-through compass (Sightmaster, Brunton, Riverton, Wyoming, USA) and distances were measured with a laser range-finder (Yardage Pro, Bushnell Sports Optics Worldwide, Overland Park, Kansas, USA). During aerial searches, general locations of geese were marked with GPS while in the aircraft followed by a ground search as described above. Other data recorded included: time of day, habitat, weather conditions (temperature, cloud cover, wind), goose activity, and number of geese with the marked goose.

Nests of transmitter-equipped geese were located when possible and nest searches were conducted to find nests of neckbanded geese. The location of each nest was recorded with GPS and the habitat surrounding each nest was documented. Goose and nest location data were plotted spatially using ArcView 3.2 (ESRI, Redlands, CA, USA).

Prior to the 2002 breeding season, an automatic receiver and data logging system (Advanced Telemetry Systems, Isanti, Minnesota, USA) were installed at BBWS to obtain additional data on goose use of BBWS. The system received signals from the transmitters over a 600 m radius, an area that encompassed the entire lagoon system and public feeding area of BBWS. The system cycled through the frequencies of the 51 transmitters approximately every 3 minutes, recording the presence or absence. Data were recorded continuously for 71 days (20 Mar–29 May 2002) with the exception of 3 days (21–23 May 2002) when the system failed.

RESULTS

Movements

During the 2001 breeding season, we located 33 marked geese (28 transmitter-equipped geese and 5 neckbanded geese) via telemetry or visual observation. We also located 33 marked geese (28 transmitter-equipped, 5 neckbanded) during the 2002 breeding season. During both breeding seasons the majority of geese were found both on and off BBWS (66%), while 18% were only located on BBWS and 16% only off the area. We documented female geese traveling as far as 109 km from BBWS.

Seventeen (15 transmitter-equipped, 2 neckbanded) of the 33 geese monitored in 2001 showed fidelity to BBWS and returned in 2002. We located marked individuals 458 times (361 on BBWS and 97 off BBWS) in 2001 and 181 times (109 on BBWS and 72 off BBWS) in 2002. Of the 17 geese monitored in both years, 13 used the same area(s) each year and 4 used new areas (>3 km from the previous year's range of locations) in addition to their previous year's range. Fig. 2 illustrates the movements of 3 transmitter-equipped geese.

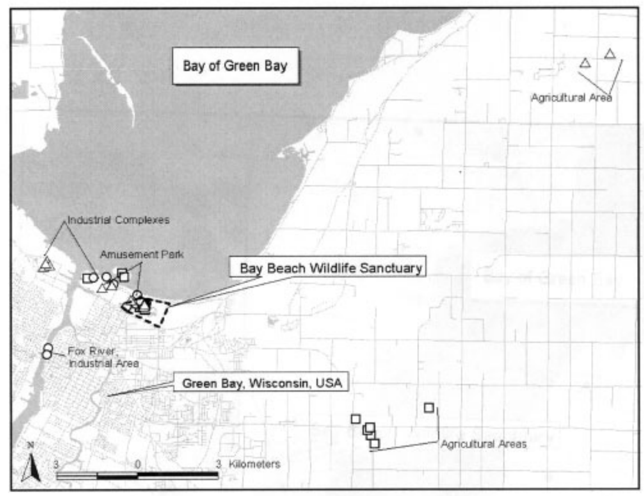

Fig. 2. Movement patterns of 3 transmitter-equipped geese. Each shape (circle, triangle and square) represents an individually marked goose. All 3 geese were frequent users of Bay Beach Wildlife Sanctuary, Green Bay, Wisconsin, USA. Locations were gathered 7 Mar–30 May, 2002, via radio telemetry and visual observation.

Nesting

In 2001, we located nests of 12 transmitter-equipped geese and 1 neckbanded goose; (7 were on BBWS and 6 were off BBWS up to 62 km away). In 2002, we located 11 nests. The nests of 6 individual geese were located in both years (Fig. 3). The data logging system allowed us to examine the movement patterns of the transmitter-equipped geese in 2002. Geese that nested away from BBWS (n = 4), did not use BBWS regularly beginning with the onset of nesting, regardless of the amount of time spent on BBWS prior to nesting. Four nested in consecutive years on BBWS and 2 off BBWS (Fig. 3). All geese nested within 60 m of the previous year's nest site, generally using the previous year's site.

Habitat Use

On BBWS, geese used parking lots, lawns, lagoons, marshes, and wooded areas for feeding and loafing. Away from BBWS, geese fed and loafed in secure industrial complexes, urban areas, public parks

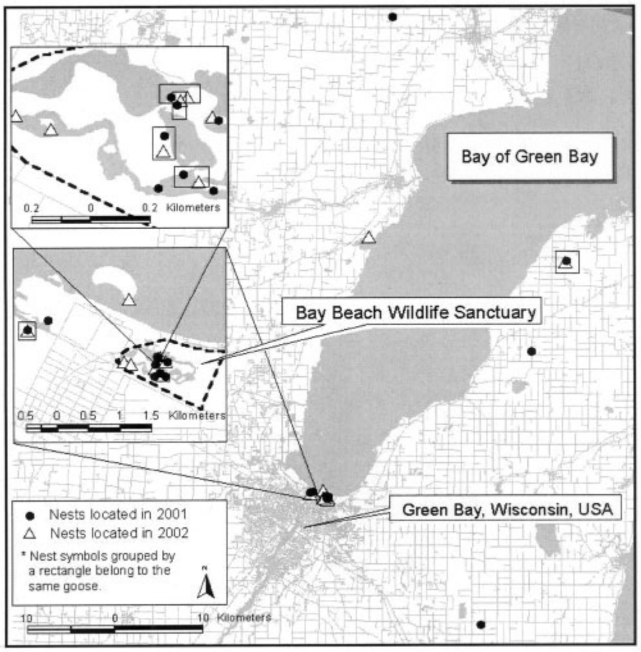

Fig. 3. Nest locations of marked geese in 2001 (n = 13, circles) and 2002 (n = 11, triangles). Symbols grouped by a rectangle represent nests of marked geese that nested both years (n = 6).

and lawns, agricultural fields, wooded areas, and remote marshes (Fig. 2). However, 3 primary locations off BBWS were noted: 1) an amusement park adjacent to the sanctuary that provided large grass lawns bordering the Bay of Green Bay, 2) agricultural fields approximately 8–12 km to the southwest of BBWS, and 3) industrial complexes 2–4 km to the west. At BBWS, the public commonly fed corn (supplied by BBWS) to geese during park hours (0800 hrs to dusk); most feeding occurred from about 1100–1700 hrs. The datalogger indicated when transmitter-equipped geese were present or absent from BBWS. A large influx of geese to BBWS occurred daily between 1100 and 1200 hrs, suggesting a prime feeding period for geese. Additionally, 16 of the 43 geese recorded by the data-logging system were only present at BBWS between 1600 and 2030 hrs, suggesting another peak feeding period.

Geese were least likely to be on BBWS between 0530–0600 hrs. Overall, 29% (n = 15) of transmitter-equipped geese were on BBWS ≥16 days during the prenesting and nesting period. Of these, 2 were present for ≥16 consecutive days. Consecutive dosing with NCZ for 16 days is thought to be the minimum requirement for an entire clutch to be effected. Sixty-eight percent of the geese were present on BBWS <10 days during this period.

Six geese died during the study. Two were legally harvested and 4 died of unknown causes. Four transmitter batteries failed and 1 transmitter broke from its neckband. All neckbanded geese without transmitters (n = 5) lived throughout the study.

DISCUSSION

We were not able to locate most geese (96%) consistently or frequently enough to have effectively delivered NCZ. Springtime goose movements were highly variable among geese, with individuals traveling <1 km to 109 km from BBWS. Time spent on and off the sanctuary also varied greatly. Use of BBWS by individual geese declined after nesting, and nest proximity to BBWS did not influence use. Some geese were residents of BBWS (18%, n = 9), using it daily for feeding, roosting, and nesting. Others were frequent visitors (12%, n = 6), using the sanctuary several days of the week for feeding and loafing. Some geese (24%, n = 12) were occasional visitors, using the sanctuary once every week or 2 weeks. Others (10%, n = 5) only visited BBWS on 1 or 2 occasions. Still other geese (22%, n = 11) only flew over the sanctuary, choosing not to use it at all. Another 24% (n = 12) of the geese were never again located in proximity to BBWS after being transmitter equipped.

Similarly, nesting sites and habitat use on and off BBWS were variable. Within BBWS, geese nested in and used secluded areas such as heavily wooded marshes as well as public areas such as the edges of parking lots. Outside of BBWS, geese used secure industrial complexes, urban areas, public parks, private agricultural land, and remote marshes both as nest sites and nonnesting habitat. Consequently, even if a goose was consistently and frequently located in an accessible area prior to nesting, she may nest in an inaccessible area, rendering her unavailable for the necessary daily NCZ dosing. We found that daily contact for 16 days (4 days prior to laying the first egg to clutch completion) was difficult to achieve. We were only able to contact 2 (4%) marked geese on ≥16 consecutive days.

If the geese were more available for oral-delivery of a reproductive inhibitor, a data-logging system and radio telemetry, in combination, would be useful for monitoring transmitter-equipped individuals. The datalogger allowed minimal effort in identification of which individuals frequented BBWS. Once it was determined which geese were routinely present, a goose could be located on the premises using hand-held radio telemetry equipment. The goose could then be approached and offered the treated feed. Currently, for most managers dealing with overabundant geese this may be too expensive and time consuming to be practical. Equipping geese with individually identifiable neckbands and visually monitoring the area for their presence each day while delivering treated feed to those present may be a less costly option.

MANAGEMENT IMPLICATIONS

Our results suggest that even if all targeted geese were marked and transmitter equipped, a significant portion of geese would remain inaccessible for dosing because they often used private and remote areas as habitat and nesting sites. Further, when away from BBWS they were not approachable. Consequently, a reproductive inhibitor, like NCZ in its current experimental form, has limited potential to be an effective management tool for reducing Canada goose numbers at BBWS or other similar sites. As it is only possible to deliver adequate doses to a limited proportion of the population, the value of this strategy for limiting Canada goose populations is minimal. Other forms of NCZ, or other chemicals with similar effects, which need be administered once (or at least less than 16 consecutive days) should be explored. VerCauteren et al. (2003) measured the grit characteristics of Canada geese and VerCauteren and Marks (2002) and Hurley and Johnston (2002) have evaluated slow-release grits as a means of delivering NCZ. Refinement is required, but slow-release systems may have potential.

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